Pion structure functions

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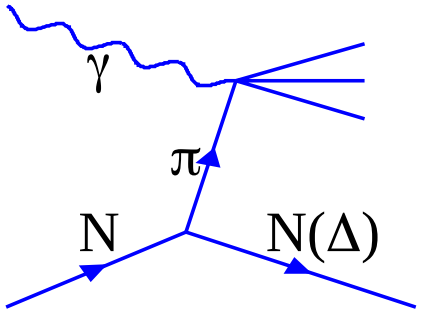
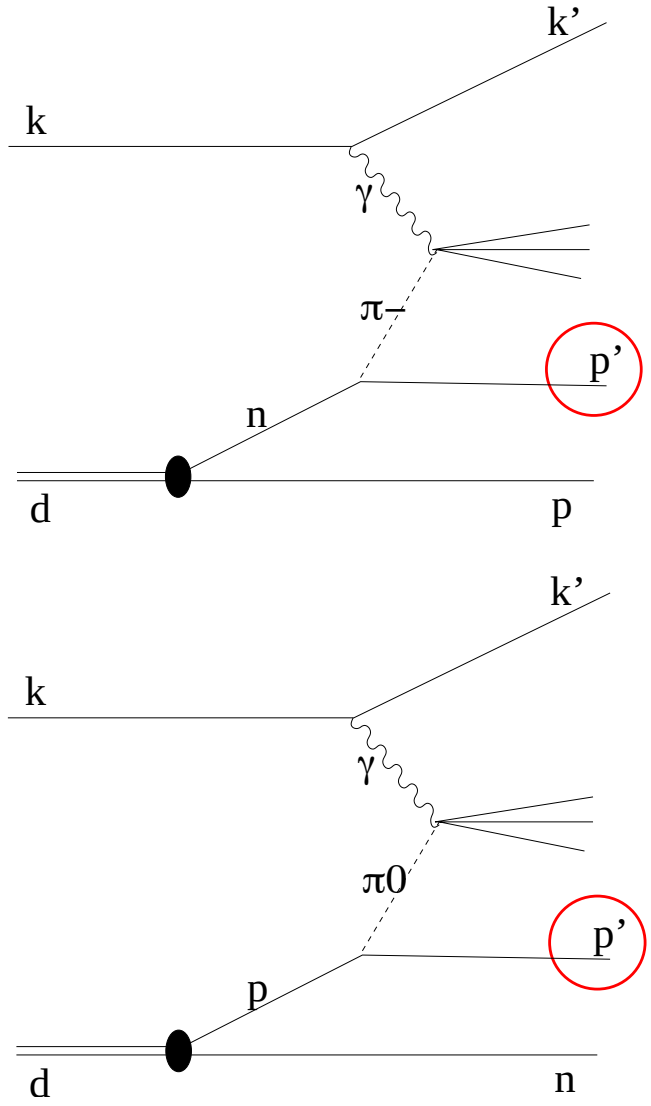
The Sullivan Process

- The Sullivan process refers to the contribution to deep inelastic scattering from the electron scattering from the meson cloud.
- The signature of the Sullivan process is a deep inelastic scattered electron detected in coincidence with a low momentum proton (or two protons for the deuterium target).
- This process could contribute a background to standard BoNuS experiments
- This measurement could be used to extract the pion structure function and provide a test of meson cloud models of the nucleon



Backgrounds from the Sullivan process

- The tagged proton detected by BoNuS during the measurement on the deuteron may not be the spectator from the DIS on the neutron
  - The neutron could undergo the Sullivan process by as a proton-π^- pair, with the resulting proton detected and the spectator proton being lost
  - The proton could undergo the Sullivan process by becoming a proton-π^0 pair, and then the detected proton would not be the spectator of the scattering

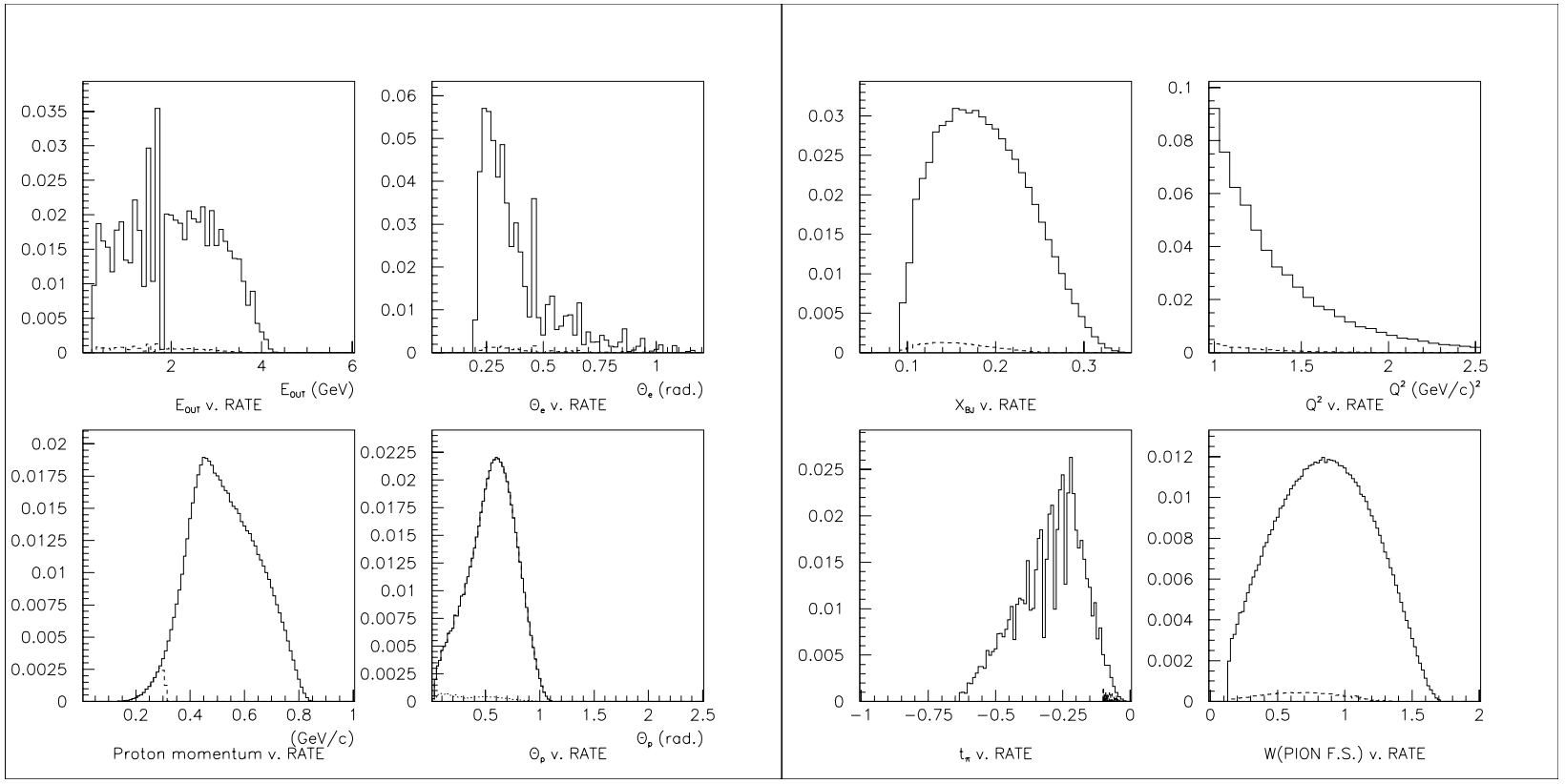


Modeling the cross section

$$\frac{d^5\sigma(ep \to e' p' X)}{dQ^2\, dx\, dp_T^2\, dz\, d\phi} = \frac{1}{2\pi} f_{p\pi^0/p}(z, p_T^2) \frac{d^2\sigma_\pi(x_\pi, Q^2)}{dQ^2\, dx_\pi}$$

- $f_{p\pi/p}$ is the probability for the proton to split into a proton-pion pair with a momentum fraction z carried by the proton, and transverse momentum p_T
- $d\sigma_\pi$ is the pion DIS cross section as a function of x_π, the x for the pion ($x_\pi = x/(1-z)$), and Q^2
- The pion DIS cross section is constructed from the pion parton distribution functions (GRV_π NLO [Z. Phys. C 53 (1992) 651]).

Simulation from a Proton Target



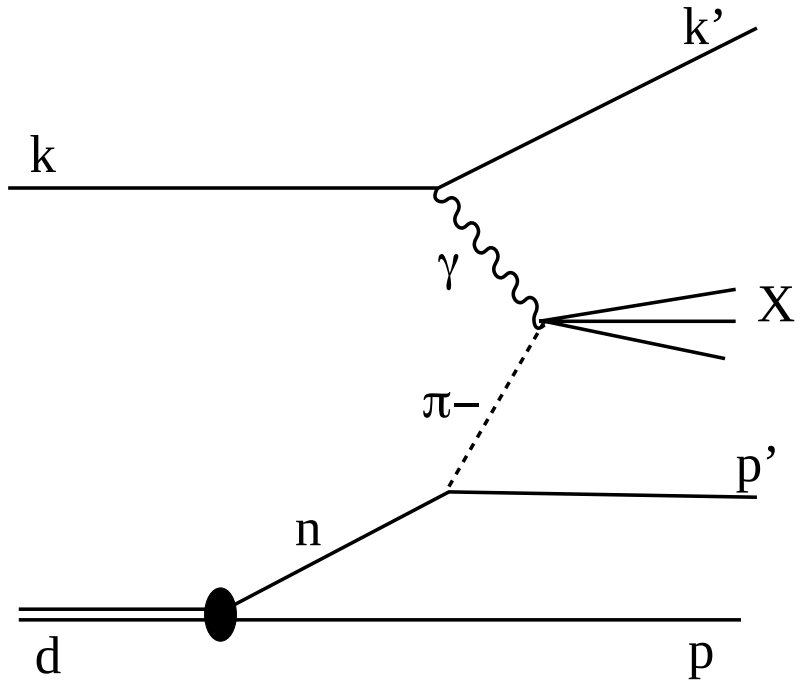
- Solid curves are without a cut in *t*, dashed are with *t>-0.1*
- The simulation indicates that the recoil protons are largely too energetic and too far forward to be detected easily in BONUS

Concerns from PAC27

- We submitted LOI-05-001 to PAC27; the LOI concentrated on the measurements from a proton target, with a brief mention of the planned continuation of simulation to the deuteron
  - The principle concerns of the PAC were:
    - Limitation of t_{max} at about -0.025 GeV^2, away from the pion pole
    - Limitation of the W of the photon-pion system to ~1.25 GeV
    - Difficulties in interpreting the cross section as arising from intermediate pions instead of contributions from higher mass mesons or Pomeron exchange
  - PAC27 did not recommend proceeding to a full proposal
- However, PAC27 did not comment on our intention to continue with simulation of a deuterium target, which process may not be subject to some of the concerns

Meson Cloud of the Neutron

- On a deuteron target, the Sullivan process will contribute to DIS from both the proton and the neutron
  - The signature from the neutron would be detection of two protons, while from the proton only one proton would be detected.

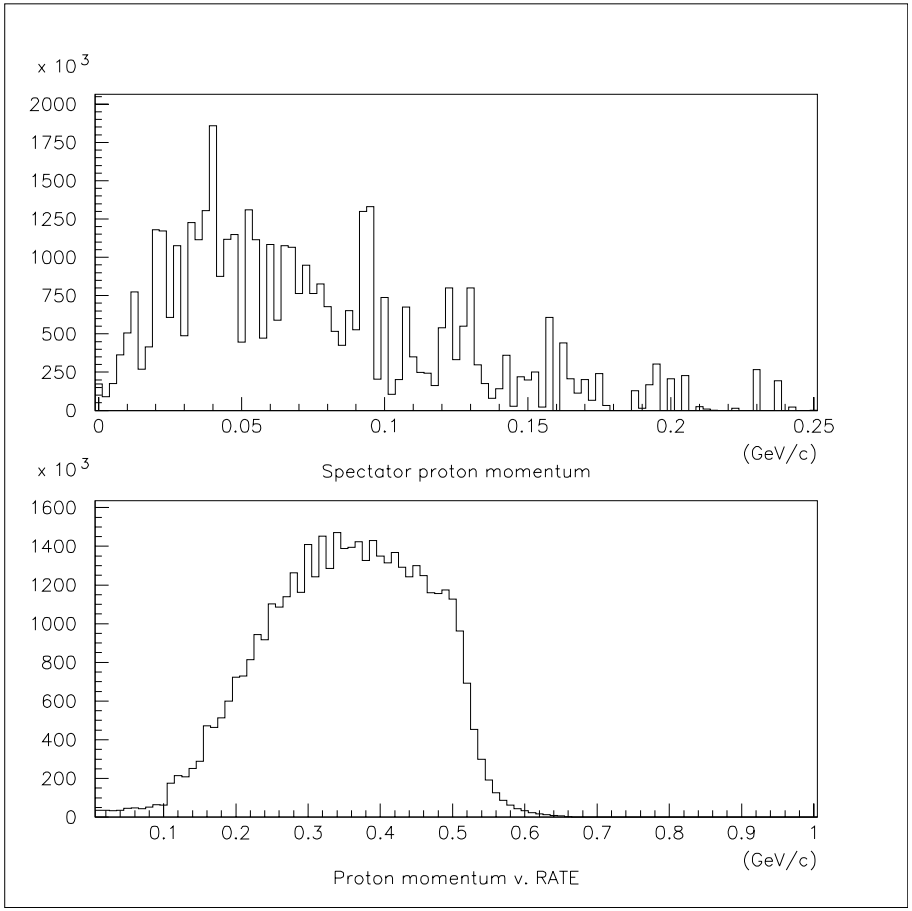


Simulation of Deuteron Target

- For our simulation we model the production of two protons through the Sullivan process on the neutron
  - The proton and neutron momentum within the deuteron is modeled with the deuteron wave function, then the proton is treated as real and the neutron as virtual
  - The neutron is then split into a proton-pion pair, and the proton is treated as real and the pion as virtual
  - The DIS from the pion is then calculated as for the proton case

Deuteron Simulation Preliminary Results

- The deuteron simulation is still at a very early stage.



Final Remarks

- Our simulation indicates that the measurement of pion DIS from a proton target is not a good match to the capabilities of BoNuS
  - This process is unlikely to produce a physics background to other BoNuS experiments on proton targets
- The simulation for DIS from the pion cloud of the neutron in a deuteron target is still in progress, our thought is that this process may be a better match to the capabilities of BoNuS
  - The possible background contribution from the Sullivan process on either the proton or neutron within the deuteron has not yet been determined